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FINAL REPORT

SCREENING SITE INSPECTION, PHASE II
BERKELEY COUNTY LANDFILL
OAKLEY, BERKELEY COUNTY, SOUTH CAROLINA
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EXECUTIVE SUMMARY

The Berkeley County Landfill is located on Landfill Road in Oakley, Berkeley County, South Carolina. The landfill received commercial, agricultural, and industrial wastes from 1972 to 1977. There is no file material available that gives information about specific wastes deposited at the site. Upon closure of the landfill, the 86-acre area was covered with 2 feet of soil, graded, and seeded.

Berkeley County is located in the Atlantic Coastal Plain Physiographic Province. The geology of the study area involves discontinuous layers of sand and clay with minor amounts of shell and limestone. There is a confining layer between the surficial aquifer and the aquifer of concern. Nearly all residential water needs in the site area are provided by groundwater from deep wells drilled in the Black Mingo Formation.

The groundwater pathway was determined to be of primary concern for this site. If contaminants from the landfill were to percolate into the underlying aquifers, an estimated 19,450 people within 4 miles of the site would be at risk.

Seventeen environmental samples were collected during the field investigation associated with this study. Several inorganic constituents were detected in surface and subsurface soil samples. One of these, lead, was detected in the nearest private well sample, indicating that contaminants may have percolated into underlying formations.

Based on the analysis of possible migration pathways, the results of the sampling investigation, and the information obtained from file material, FIT 4 recommends that Phase I of a Listing Site Inspection be initiated at the Berkeley County Landfill.

2.0 SITE CHARACTERIZATION

2.1 SITE BACKGROUND AND HISTORY

The Berkeley County Landfill, which is located 3 miles west of Oakley, South Carolina, is owned by Mr. Gene Neighbors and was leased to the county during its operation (Ref. 1). The landfill was used from 1972 to 1977 to receive primarily domestic waste, but it also received commercial, agricultural, and industrial waste (Ref. 1). The site location is shown on Figure 1.

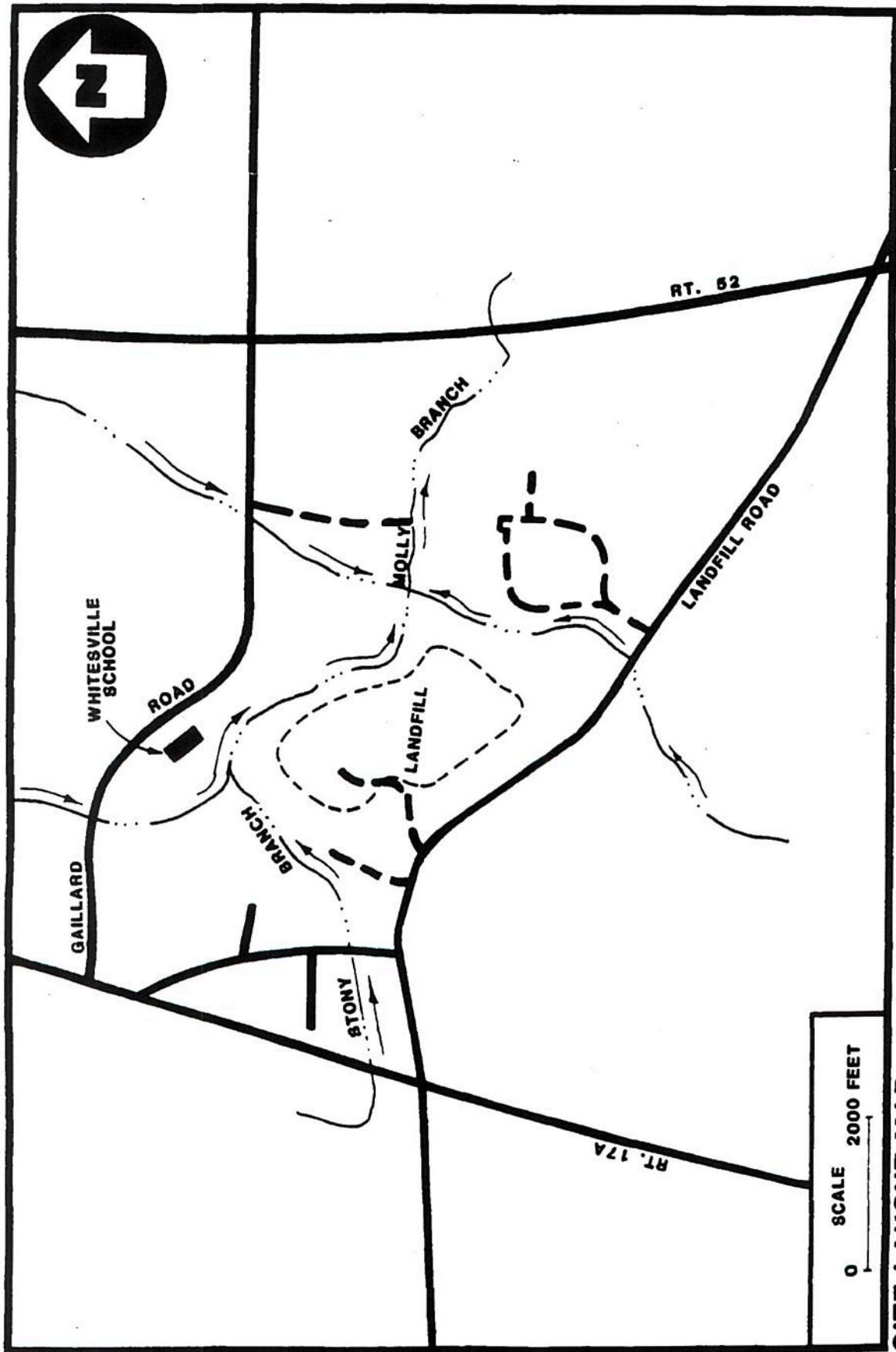
No file material is available on specific wastes that were disposed of in the landfill. However, a new county landfill site, Permit No. DWP021, was established upon closure of the old Berkeley County Landfill. The wastes disposed of at the new site include plastics, waste oil, titanium dioxide, sludge from textile operations, bark sludge, epoxy resins, chemical containers, scrap metal, and miscellaneous trash - all from area industries. Although none of the materials disposed of in the new landfill are known to be in the old site, it is possible that some or all of these may have been placed in the old site prior to 1976 (Ref. 1).

2.2 SITE DESCRIPTION

2.2.1 Site Features

The inactive landfill which is estimated at 6 feet deep covers an area of approximately 86 acres (Ref. 2). It is bounded on all sides by thick woods, and Molly Branch, which was dry during the field investigation, is adjacent to the north. The landfill itself is densely vegetated with pine trees and brush, and the surrounding area is relatively flat.

The property is completely surrounded by a fence, and the only entrance is through a locked gate located on the southwest end of the property. The land adjacent to the landfill is pine forested and undeveloped except for a few homes (Ref. 1, p. 3). The site layout is shown in Figure 2 (Ref. 3, Appendix A). The site layout is depicted in Figure 2.



**SITE LAYOUT MAP
BERKELEY COUNTY LANDFILL
OAKLEY, BERKELEY COUNTY, SOUTH CAROLINA**

FIGURE 2



3.0 REGIONAL POPULATIONS AND ENVIRONMENTS

3.1 POPULATION AND LAND USE

3.1.1 Demography

The Berkeley County Landfill site is located in a rural area approximately 3 miles west of Oakley, South Carolina (Appendix A). Population within a 1-mile radius of the site is approximately 433; within a 4-mile radius, the population is estimated to be 4,402 (Ref. 4). The nearest residence is located approximately 200 feet southeast of the landfill (Ref. 3). The Whitesville Elementary School is located about 1,300 feet northwest of the landfill on Gaillard Road (Appendix A).

3.1.2 Land Use

The vast majority of the area within a 4-mile radius of the landfill is rural with scattered residential areas. This area also contains many isolated wetlands and the ranges of three federally endangered species of birds. These birds include the bald eagle (Haliaeetus leucocephalus), the Bachman's warbler (Vermivora bachmanii), and the red-cockaded woodpecker (Picoides (Dendrocopos) borealis) (Ref. 5).

3.2 SURFACE WATER

3.2.1 Climatology

Berkeley County has a subtropical climate with warm summers, mild winters, and ample precipitation. Rainfall is well distributed throughout the year. The annual distribution shows a maximum precipitation of about 7 inches in July and a minimum of about 2 inches in November (Ref. 6). The net annual precipitation is approximately 13.5 inches (Ref. 7). The mean annual temperature for this area is approximately 64°F (Ref. 6, p. 93).

3.2.2 Overland Drainage

Surface water run-off from the landfill flows east approximately 700 feet into Molly Branch and southeast approximately 1,000 feet into an unnamed tributary. Molly Branch flows east, and the unnamed tributary flows north into Molly Branch.

(Ref. 12, p. 17). The formation is approximately 340 feet thick in this area (Ref. 12, p. 13). The Peedee Formation is represented by calcareous clays and silty sands that are approximately 320 feet thick (Ref. 12, pp. 13, 17). The Black Creek Formation consists of interbedded sands and clays that are 700 feet thick (Ref. 12, pp. 14, 17). The Middendorf Formation is composed of clays in the lower half with silty sand in the upper. It is encountered at a depth of 1,560 feet bls in the landfill area (Ref. 12, pp. 11, 13, 17).

The primary aquifer used in this area is groundwater from the Santee Limestone and Black Mingo Formation (Ref. 12, pp. 30-34). A significant amount of hydraulic interconnection occurs between the base of the Santee and the upper half of the Black Mingo Formation in this area (Ref. 12, p. 32). Most wells are of open-hole construction and penetrate into the sand beds of the Black Mingo Formation (Refs. 12, 31). These wells occur under artesian conditions due to the overlying confining clays of the Cooper Formation and the basal Black Mingo (Ref. 12, p. 30). The water level is approximately 25 feet bls in the landfill area (Ref. 12, p. 33). Water yields of 432,000 gal/day have been reported from wells in this area (Ref. 12, p. 31). The hydraulic conductivity for sediments similar to these is approximately 1.0×10^{-5} cm/sec (Ref. 12, p. 29).

Groundwater does occur in the deeper formations but, due to the quality of water and expense involved in completing wells, these aquifers are not used in the Berkeley landfill area (Ref. 12, pp. 27-30). Rainfall is the main source of recharge to the aquifers (Ref. 12, p. 32). Water quality from the Santee Limestone - Black Mingo Formation aquifer is generally good in this area but deteriorates downgradient due to increasing amounts of sodium, fluoride, and chlorides (Ref. 12, pp. 44, 53).

3.3.2 Aquifer Use

Greater than 70 percent of the residents within a 4-mile radius of the site receive their potable water from private wells (Ref. 8). These wells are cased in the Black Mingo aquifer (300 to 500 feet bls) which is the aquifer of concern (Ref. 16). The closest private well, which is located roughly 200 feet east of the landfill, is approximately 300 feet deep (Ref. 3, Appendix A).

Those residents without private wells are serviced by the Berkeley County Water Department. This department has approximately 5,000 connections. Fifty percent of the Berkeley County water is surface water supplied by the Charleston City Public Works which has a surface water intake on the Edisto River approximately 30 miles west of the landfill. The Edisto River is not along the surface water migration pathway (Ref. 17). Water from the Charleston system is mixed, prior to distribution, with the water from three municipal wells (Refs. 4, 8). One of these wells is located approximately 2.25 miles north of the landfill; the second is approximately 2 miles northeast of the landfill; the third

4.0 FIELD INVESTIGATION

4.1 GEOPHYSICAL INVESTIGATION

Geophysics was to be utilized in order to better characterize the boundaries of the landfill. Upon arrival at the site, it was realized that because the landfill is very densely overgrown, and there was much damage (i.e., fallen trees) resulting from 1989's Hurricane Hugo, it would not be possible to perform geophysical techniques.

4.2 FIELD ANALYTICAL SCREENING PROJECT (FASP)

FASP was to be used in conjunction with Geophysics. FASP at this site was therefore canceled upon realization of the physical constraints posed by the field conditions.

4.3 SAMPLE COLLECTION

4.3.1 Sample Collection Methodology

All sample collection, sample preservation, and chain-of-custody procedures used during this investigation were in accordance with the standard operating procedures as specified in Sections 3 and 4 of the Engineering Support Branch Standard Operating Procedures and Quality Assurance Manual; United States Environmental Protection Agency, Region IV, Environmental Services, Division, April 1, 1986.

4.3.2 Duplicate Samples

Mr. G. Neighbors, landfill owner, declined duplicate samples collected at the Berkeley County Landfill (Ref. 18). The owners of the private wells located off site also declined duplicate groundwater samples.

4.3.3 Description of Samples and Sample Locations

Seventeen environmental samples were collected for the investigation: four surface soil, four subsurface soil, two temporary well, two private well, and five sediment samples. Sample locations are shown in Figure 3. Sample codes, descriptions, and rationale are contained in Table 1.

TABLE 1

SAMPLE CODES, DESCRIPTION, LOCATION, AND RATIONALE
BERKELEY COUNTY LANDFILL
OAKLEY, BERKELEY COUNTY, SOUTH CAROLINA

Sample Code	Description	Location	Rationale
BL-SD-01	Sediment	Upstream, west of site on Molly Branch	To provide background values
BL-SD-02	Sediment	Northwest of site on an unnamed tributary of Molly Branch	To determine presence or absence of contaminants
BL-SD-03	Sediment	West of intersection of Molly Branch and unnamed tributary east of site	Not collected
BL-SD-04	Sediment	Southeast of site on unnamed tributary of Molly Branch	To determine presence or absence of contaminants
BL-SD-05	Sediment	North intersection of Molly Branch and unnamed tributary east of site	To determine presence or absence of contaminants
BL-SD-06	Sediment	Downstream on Molly Branch	To determine presence or absence of contaminants
BL-SS-01 BL-SB-01 BL-TW-01	Surface Soil Subsurface Soil Groundwater	Upgradient, west of site	To provide background values
BL-SS-02 BL-SB-02	Surface Soil Subsurface Soil	Northwestern edge of landfill	To determine presence or absence of contaminants
BL-TW-02	Groundwater	Northwestern edge of landfill	Not collected
BL-SS-03 BL-SB-03 BL-TW-03	Surface Soil Subsurface Soil Groundwater	Southern edge of landfill	Not collected
BL-SS-04 BL-SB-04	Surface Soil Subsurface Soil	Southeastern edge of landfill	To determine presence or absence of contaminants attributable to the site
BL-TW-04	Groundwater	Southeastern edge of landfill	Not collected
BL-SS-05 BL-SB-05 BL-TW-05	Surface Soil Subsurface Soil Groundwater	Northeastern edge of landfill	To determine presence or absence of contaminants attributable to the site

BL - Berkeley County Landfill
SD - Sediment
SS - Surface Soil

SB - Subsurface Soil
TW - Temporary Well
PW - Private Well

4.3.4 Field Measurements

Field measurements were recorded for the groundwater samples. Parameters measured included temperature, pH, and conductivity of the sample at the time of collection. No field measurements were performed on the soil samples during the investigation. The groundwater data are presented in Table 2.

4.4 SAMPLE ANALYSIS

4.4.1 Analytical Support and Methodology

All samples collected were analyzed under the Contract Laboratory Program (CLP) and analyzed for all parameters listed in the Target Compound List (TCL). Organic analysis of soil and water samples was performed by S-Cubed, San Diego, California. Inorganic analysis of soil and water was performed by Skinner & Sherman, Waltham, Massachusetts.

All laboratory analyses and laboratory quality assurance procedures used during this investigation were in accordance with standard procedures and protocols as specified in the Laboratory Operations and Quality Control Manual, United States Environmental Protection Agency, Region IV, Environmental Services Division, October 24, 1990; or as specified by the existing United States Environmental Protection Agency standard procedures and protocols for the contract analytical laboratory program.

4.4.2 Analytical Data Quality

All analytical data were subjected to a quality assurance review as described in the EPA Environmental Services Division laboratory data guidelines. In the tables, some of the concentrations of the organic and inorganic parameters have been flagged with a "J". This indicates that the qualitative analysis was acceptable, but the quantitative value has been estimated. A few other compounds are flagged with an "N", indicating that they were detected based on the presumptive evidence of their presence. This means that the compound was tentatively identified, and its detection cannot be used as positive identification to its presence. Many compounds in the background samples are flagged with a "U". This means that the compound was analyzed for but was not detected, and the value is used as the minimum quantitation limit. The complete analytical data sheets are provided in Appendix C.

4.4.3 Presentation of Analytical Results

This section discusses the results from the analysis of the environmental samples collected during the investigation at the Berkeley County Landfill. Results for inorganic and organic analyses of surface soil, subsurface soil, sediment, and groundwater samples are presented in Tables 3 through 10. Throughout the following discussion, concentrations will be described as elevated. This means that the concentration is at least three times that found in the background sample or at least three times the minimum quantitation limit (MQL) of that contaminant in the background sample.

The organic analytical results can be found in Tables 3, 5, 7, and 9. From the southeast corner of the landfill, a surface and subsurface soil sample were collected (BL-SS-04 and BL-SB-04). The surface soil sample contained tetrachloroethene at an estimated concentration four times that found in the background sample. The subsurface soil sample was found to contain carbon disulfide at a concentration four times MQL.

Samples BL-SS-05, BL-SB-05, and BL-TW-05 were collected from the northeast corner of the landfill. The surface soil sample was free of organic contaminants, while the subsurface soil and groundwater samples contained elevated amounts of chlorobenzene. The concentration detected in the subsurface soil sample was four times MQL, and that detected in the groundwater was 24 times MQL.

A sediment sample BL-SD-05 was collected from an unnamed creek northeast of the landfill. Tetrachloroethene was detected in this sample at a concentration two times MQL. This sample was collected upstream from the site; therefore, the contamination cannot be attributed to the site.

File material indicates that the landfill received waste from area industries. The three organic contaminants detected in elevated amounts are commonly used in a wide variety of industries. Chlorobenzene, for example, is used to make pesticides, dyes, chemicals, and as a solvent for dry cleaning and color printing (Ref. 19). Tetrachloroethene is a commonly used solvent and is also used in dry cleaning, metal degreasing, and textile processing (Ref. 20). Carbon disulfide is principally used in the manufacturing of regenerated cellulose fibers and films, as a raw material for the manufacturing of carbon tetrachloride, and can be used as a solvent in some instances (Ref. 21).

The inorganic analytical results can be found in Tables 4, 6, 8, and 10. A surface and subsurface soil sample were collected from the northwest boundary of the landfill. The surface soil sample, BL-SS-02, contained 10 metals in elevated levels ranging from 5 to 20 times background or MQL. These metals include aluminum, barium, calcium, chromium, iron, magnesium, nickel, potassium, sodium, and vanadium. The subsurface soil taken at this sample location (BL-SB-02) contained seven metals in

TABLE 4
SUMMARY OF INORGANIC ANALYTICAL RESULTS
SURFACE SOIL SAMPLES
BERKELEY COUNTY LANDFILL
OAKLEY, BERKELEY COUNTY, SOUTH CAROLINA

PARAMETERS (mg/kg)	Background	Northwest Corner of Landfill	Southeast Corner of Landfill	Northeast Corner of Landfill
	BL-SS-01	BL-SS-02*	BL-SS-04	BL-SS-05
ALUMINUM	2600	17,000	7600	6000
ARSENIC	2J	3.4	-	-
BARIUM	21	120	27	25
BERYLLIUM	1U	2.8	-	-
CALCIUM	1000	5200	2700	3500
CHROMIUM	2U	25	10	7.2
COBALT	1.3U	2.7	-	3.4
IRON	1500	15,000	8500	5400
LEAD	8.4J	18J	11J	14J
MAGNESIUM	150	1600	300	340
MANGANESE	15	25	84	350
NICKEL	1.1U	5.5	2.7	2.3
POTASSIUM	60U	1200	260	170
SODIUM	30U	250	-	-
VANADIUM	4.2	36	14	7.2
ZINC	4U	-	22	-

- Material analyzed for but not detected above minimum quantitation limit (MQL).

J Estimated value.

U Material was analyzed for but not detected. The number given is the MQL.

*Note: Sample BL-SS-03 was not collected, because the sample location was inaccessible.

TABLE 6

**SUMMARY OF INORGANIC ANALYTICAL RESULTS
SUBSURFACE SOIL SAMPLES
BERKELEY COUNTY LANDFILL
OAKLEY, BERKELEY COUNTY, SOUTH CAROLINA**

PARAMETERS (mg/kg)	Background	Northwest Corner of Landfill	Southeast Corner of Landfill	Northeast Corner of Landfill
	BL-SB-01	BL-SB-02*	BL-SB-04	BL-SB-05
ALUMINIUM	27,000	7500	7900	18,000
ARSENIC	2U	2.8	6.5	8.3
BARIUM	37	23	70	87
CADMIUM	0.66U	-	-	3.9
CALCIUM	30U	140,000	140,000	15,000
CHROMIUM	9.1	39	38	87
COBALT	1.5U	-	-	4
IRON	2200	9000	10,000	17,000
LEAD	17J	4.7J	4.3J	7J
MAGNESIUM	130	3700	5300	4700
MANGANESE	3U	65	81	160
NICKEL	6.2	11	12	17
POTASSIUM	130U	3400	2800	3300
SODIUM	40U	670	490	480
VANADIUM	11	14	13	34
ZINC	3U	-	-	95

- Material analyzed for but not detected above minimum quantitation limit (MQL).

J Estimated value.

U Material was analyzed for but not detected. The number given is the MQL.

*Note: Sample BL-SB-03 was not collected, because the sample location was inaccessible.

Samples BL-SB-06, 07, 08, and 09 were not collected due to a decision not to collect any samples on the actual landfill surface.

TABLE 8

SUMMARY OF INORGANIC ANALYTICAL RESULTS
SEDIMENT SAMPLES
BERKELEY COUNTY LANDFILL
OAKLEY, BERKELEY COUNTY, SOUTH CAROLINA

PARAMETERS (mg/kg)	Background	Unnamed Creek Northwest of Landfill	Unnamed Creek Southeast of Landfill	Unnamed Creek Northeast of Landfill	East of Landfill on Molly Branch
	BL-SD-01	BL-SD-02*	BL-SD-04	BL-SD-05	BL-SD-06
ALUMINUM	7000	1600	8100	2200	1100
BARIUM	80	10	24	-	78
CALCIUM	1800	-	2600	480	420
CHROMIUM	4U	-	81	-	-
IRON	2200	590	11,000	3300	790
LEAD	38J	5.3J	13J	7.4J	2.6J
MAGNESIUM	320	46	580	-	-
MANGANESE	16	-	21	6.7	6.8
NICKEL	2.9	-	3	-	-
POTASSIUM	250	-	440	-	-
VANADIUM	8.5	2.8	14	5.1	2.4

- Material analyzed for but not detected above minimum quantitation limit (MQL).

J Estimated value.

U Material was analyzed for but not detected. The number given is the MQL.

*Note: Sample BL-SD-03 was not collected, because the sample location was inaccessible.

TABLE 10

**SUMMARY OF INORGANIC ANALYTICAL RESULTS
GROUNDWATER SAMPLES
BERKELEY COUNTY LANDFILL
OAKLEY, BERKELEY COUNTY, SOUTH CAROLINA**

PARAMETERS (ug/l)	Preservative Blank	Background		Private Well East of Site	Northeast Corner of Landfill
	BL-PB-01	BL-PW-01	BL-TW-01	BL-PW-02	BL-TW-05
ALUMINUM	110J	110UJ	7800J	-	1300J
ARSENIC	-	2UJ	2UJ	-	110J
BARIUM	-	2U	75	-	64
CALCIUM	-	2900	850U	2700	150,000
COBALT	-	4U	5U	-	65
IRON	-	90UJ	2800J	-	46,000J
LEAD	-	24J	5J	55J	-
MAGNESIUM	-	1400	1600	1400	12,000
MANGANESE	-	2U	5U	-	3300
NICKEL	-	6U	6U	-	33
POTASSIUM	-	9000	990	9200	6100
SODIUM	-	160,000	23,000	170,000	57,000
VANADIUM	-	4U	8	-	8

- Material analyzed for but not detected above minimum quantitation limit (MQL).

J Estimated value.

U Material was analyzed for but not detected. The number given is the MQL.

Note: Samples BL-TW-02 and BL-TW-04 were not collected, because groundwater could not be reached.

Sample BL-TW-03 was not collected, because the sample location was inaccessible.

5.0 SUMMARY

The groundwater pathway is of primary concern at the Berkeley County Landfill. Approximately 3,200 people are considered at risk from potential releases of contaminants to the aquifer of concern.

The sampling investigation consisted of the collection of 17 environmental samples: four surface soil, four subsurface soil, two temporary well, two private well, and five sediment samples. BL-TW-05 was the only groundwater sample that showed significant concentrations of contaminants. Chlorobenzene (24 times MQL) and arsenic (55 times MQL, estimated) are the only two contaminants detected in the groundwater that would warrant any concern. However, this temporary well was 6.5 feet deep, therefore not representing the aquifer of concern. The private well that was sampled downgradient of the landfill contained lead at levels exceeding the EPA's level for drinking water. This well obtains water from the aquifer of concern.

Based on the analysis of possible migration pathways, the results of the sampling investigation, and the information obtained from the references, FIT 4 recommends that Phase I of a Listing Site Inspection be initiated at the Berkeley County Landfill.

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